CLAIMS

What is claimed is:

1. A method for plasma processing, comprising the actions of:
   (a.) generating an electron-free ion-ion plasma in proximity to at least one substrate; and
   (b.) controlling bias to said substrate, at times when said ion-ion plasma is present, to induce bombardment of said substrate by ions of desired polarity and energy, with substantially no electron bombardment.

2. The method of Claim 1, wherein said chamber contains a gas phase having high net electron affinity.

3. The method of Claim 1, wherein said bias signal controls an AC bias.

4. A method for plasma processing, comprising the actions of:

(a.) repeatedly applying power pulses to a chamber, to thereby increase the total ion density inside said chamber;

(b.) and, AFTER one of said power pulses AND AFTER sufficient time for the electron density to drop to less than 1/200th of the positive ion density, applying a bias signal to a substrate to induce ion bombardment of said substrate;

wherein said sufficient time substantially prevents bombardment of said substrate by free electrons during said action (b.).

5. The method of Claim 4, wherein said chamber contains a gas phase having high net electron affinity.

6. The method of Claim 4, wherein said pulses oscillate between a maximum level of power which increases plasma density and a nonzero minimum level which allows electron attachment.

7. The method of Claim 4, wherein said bias signal is modulated at a frequency which is integrally related to the switching frequency of said power pulses.

8. The method of Claim 4, wherein said power pulses are pulses of RF power.

9. The method of Claim 4, wherein said bias voltage is applied with both positive and negative polarities, to induce bombardment at different times with both negative and positive ions.

10. The method of Claim 4, wherein said power pulses are pulses of RF power.

11. The method of Claim 4, wherein said power pulses are pulses of RF power, and wherein said bias signal controls AC bias at a frequency lower than said RF power in said power pulses.

12. The method of Claim 4, wherein said bias signal is phase-locked to said power pulses.

13. The method of Claim 4, wherein said bias signal controls an AC bias.

14. A method for surface modification by negative ion bombardment, comprising the actions of:

(a.) generating a population of negative ions in proximity to a substrate; and

(b.) applying a bias signal to induce bombardment of said substrate by said negative ions, but only at times when said negative ions outnumber free electrons by more than 200 to 1;

whereby self-biasing of said substrate is prevented.

15. The method of Claim 14, wherein said chamber contains a gas phase having high net electron affinity.

16. The method of Claim 14, wherein said bias voltage is applied with both positive and negative polarities, to induce bombardment at different times with both negative and positive ions.

17. The method of Claim 14, wherein said power pulses are pulses of RF power.

18. The method of Claim 14, wherein said bias signal controls an AC bias.

19. A method for plasma processing, comprising the actions of:

(a.) applying power pulses to a chamber, using an intensity modulation waveform, to thereby increase the total ion density in said chamber;

(b.) and applying a bias signal, whose envelope is synchronized to said modulation waveform, to a substrate;

wherein a delay is imposed, between at least some trailing edges of said modulation waveform and respective next leading edges of said bias signal envelope, which is sufficient for the free electron density to fall to less than 0.5% of the positive ion density inside said chamber.

20. The method of Claim 19, wherein said chamber contains a gas phase having high net electron affinity.

21. The method of Claim 19, wherein said pulses oscillate between a maximum level of power which increases plasma density and a nonzero minimum level which allows electron attachment.

22. The method of Claim 19, wherein said bias signal is modulated at a frequency which is integrally related to the switching frequency of said power pulses.

23. The method of Claim 19, wherein said power pulses are pulses of RF power.

24. The method of Claim 19, wherein said bias voltage is applied with both positive and negative polarities, to induce bombardment at different times with both negative and positive ions.

25. The method of Claim 19, wherein said power pulses are pulses of RF power.

26. The method of Claim 19, wherein said power pulses are pulses of RF power, and wherein said bias signal controls AC bias at a frequency lower than said RF power in said power pulses.

27. The method of Claim 19, wherein said bias signal is phase-locked to said power pulses.

28. The method of Claim 19, wherein said bias signal controls an AC bias.

29. A method for plasma processing, comprising the actions of:

(a.) applying power pulses to a chamber at a first frequency, to thereby increase the total ion density in said chamber;

(b.) and repeatedly applying a bias signal, at a switching frequency which is integrally related to said first frequency, to at least one substrate;

wherein a delay is imposed, between at least some trailing edges of said power pulses and respective next leading edges of said bias signal, which is sufficient for the free electron density to fall to less than 0.5% of the positive ion density inside said chamber.

30. The method of Claim 29, wherein said chamber contains a gas phase having high net electron affinity.

31. A method for plasma processing, comprising the actions of:

(a.) generating an electron-free ion-ion plasma in proximity to at least first and second substrates; and

(b.) applying different respective bias signals to said substrates, at times when said ion-ion plasma is present,

to induce bombardment of said first substrate by ions of desired chemistry and energy, with substantially no electron bombardment, and

to regulate the voltage and/or composition of said plasma by ion bombardment of said second substrate.

32. The method of Claim 31, wherein said chamber contains a gas phase having high net electron affinity.

33. An ion-ion-plasma processing system, comprising:

a chamber;

circuitry which repeatedly applies power pulses to increase the total ion density of a glow discharge in said chamber; and

circuitry which repeatedly applies a bias signal to a substrate, after said first circuitry has completed one of said power pulses and after sufficient time for attachment of free electrons in said glow discharge, to induce bombardment of said substrate by ions and not by electrons.